State of California Business Transportation and Housing Agency

# Memorandum

**To:** ALL DISTRICT DIRECTORS
CHIEF, DIVISION OF ENGINEERING SERVICES and
CHIEF, DIVISION OF TRANSPORTATION PLANNING
ALL HOLDERS OF THE HIGHWAY DESIGN MANUAL and
ALL HOLDERS OF THE TRAFFIC MANUAL

**Date:** June 15, 2001

**File:**

**From** **DEPARTMENT OF TRANSPORTATION**
**DIVISION OF DESIGN**
**MS 28**

**Subject:** Single Point Interchange Planning, Design, and Operations Guidelines

The Single Point Interchange Quality Team (SPI Team) has developed guidelines for single point interchange (SPI) alternatives. These guidelines are available on the internet at http://www.dot.ca.gov/hq/oppd/ and are effective immediately. The SPI Interim Design criteria issued March 30, 2000 are superseded.

The Chief, Division of Design and the Chief, Division of Traffic Operations must approve the concept for all SPIs. This authority has been delegated to the Project Development Coordinator and the Traffic Liaison respectively. Concept approval is required prior to approval of the Project Study Report except when the project is initiated with a Project Study Report (Project Development Support). In this case concept approval for an SPI alternative should be obtained as early in the environmental study phase as reasonable, but shall be obtained prior to approval of the Draft Project Report. In addition the HQ Traffic Liaison shall approve all final signing, striping and signalization plans for SPIs.

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# Single Point Interchange
# Planning, Design and Operations Guidelines

## INTRODUCTION

These guidelines have been prepared as a comprehensive document covering planning, design and operations of Single Point Interchanges (SPIs). Any SPI within the state right of way must conform to these guidelines. Items not covered shall be in accordance with the Project Development Procedures Manual (PDPM), Highway Design Manual (HDM), Traffic Manual (TM), Ramp Metering Design Manual (RMDM) as well as all other current applicable California Department of Transportation standards and guidelines. The SPI Planning, Design and Operations Guidelines provide a guide for the engineer to exercise sound judgement consistent with the project development philosophy discussed in Chapter 80 of the HDM.

The SPI is an interchange configuration that combines the two separate diamond ramp intersections into a single large at-grade intersection. The SPI, sometimes referred to as an "urban interchange", has been known to most highway agencies for many years, but was seldom used because of its cost, difficulty in constructing and unknown performance characteristics. In recent years, however, the SPI has become increasingly popular in a few states and local agencies. SPIs should be used under specific situations and should not be selected because the interchange is considered “state of the art” or a "gateway" concept.

## SECTION 1 – PLANNING, APPLICATION AND APPROVAL OF SINGLE POINT INTERCHANGES

### 1-100 APPROVAL OF SPIs

The Headquarters Chief, Division of Design and the Headquarters Chief, Division of Traffic Operations must approve the concept for all SPIs. This authority has been delegated to the Project Development Coordinator and the Traffic Liaison respectively. Concept approval is required prior to approval of the Project Study Report except when the project is initiated with a Project Study Report (Project Development Support). In this case concept approval for an SPI alternative should be obtained as early in the environmental study phase as reasonable, but shall be obtained prior to approval of the Draft Project Report. In addition the HQ Traffic Liaison shall approve all final signing, striping and signalization plans for SPIs.

## 1-200 GEOMETRIC CONSIDERATIONS

Any SPI proposal must be compared to other conventional interchange types. Consistent with the philosophy of the PDPM, several interchange alternatives should be evaluated. The SPI alternative should be compared in particular to spread diamonds, L-9 partial cloverleaves (parclo) and tight diamonds. The type of interchange selected should be based on the discussions in these guidelines in order to select the best overall interchange configuration.

SPI intersections are larger than other intersections. Many existing SPI intersections are 90 meters in length or longer. Most SPI intersections operate with a three-phase signal. A significant distance separates the right turn lanes at exit ramps from the left turn lanes. Because of its unique design, certain geometric features are more critical to the SPIs operation than to other types of interchanges. Among those features are crest vertical curvature, skew angles, intersection length, and large radius sweeping left turn moves. See Section 2, "Geometric Design" for detailed discussion of these design items.

California drivers are relatively unfamiliar with the SPI geometric and operational characteristics. Therefore the selection of an interchange type should consider the number of non-repeat drivers who may not be familiar with the SPI. These locations should include, but are not limited to, airports, hospitals, sports stadiums and resort areas. Additional consideration should be provided to locations where visibility may be reduced by weather conditions.

## 1-300 RIGHT OF WAY CONSIDERATIONS

The available right of way (R/W) is an important consideration in selecting the appropriate interchange type. Where adequate R/W is available, the first choices of interchange types as described in the HDM are an L-9 (parclo) or an L-2 (spread diamond). These interchange types provide a high degree of safety, capacity, and flexibility while still meeting driver expectations. In situations where R/W is very restrictive, the most common interchange considered is the tight diamond, and in certain rare circumstances an SPI. The right of way requirements for SPIs and tight diamonds are similar.

## 1-400 CAPACITY

When the SPI configuration is unconstrained by the local road system, it has the capability of handling larger volumes of traffic than the tight diamond. However, in urban situations the local road system is often the controlling factor for overall system capacity. The following constraints influence the selection of an SPI:

Intersection Size

The size of SPI intersections necessitates a long traffic signal clearance interval for all moves. The all-red clearance interval represents dead time to the signal timing cycle, which reduces capacity and efficiency. This needs to be considered during the planning stage of the SPI design.

Adjacent Intersections

The proximity of adjacent intersections and driveways to ramp termini is a critical factor in the operation of any interchange. Under moderate to heavy traffic demands, SPIs require longer signal cycle lengths to maximize operations. When an SPI configuration is used, intersection spacing becomes even more critical because all stopped traffic must be stored between the near stop bar and the adjacent intersection. Often free right turn moves at exit ramps can not be provided due to close proximity of adjacent intersections. See Section 2-300, Right Turns at Exit Ramps" and HDM Index 504.3(2), "Location and Design of Ramp Intersections on the Crossroads", and 504.8 "Access Control" for more information.

Left Turn Movements

SPIs are generally more efficient than tight diamond interchanges in handling large volumes of left turn traffic where it can be accommodated by the receiving roadway. Tight diamond interchanges typically perform better than SPIs when handling large through volumes on the local streets. SPIs are more efficient for high left turning truck volumes due to their large left turn radii. SPIs may not operate efficiently when the moves are unbalanced.

Storage Capacity on Metered Ramp

An SPI can deliver significantly more left turn traffic volume to entrance ramps. Therefore adequate storage capacity shall be provided on metered ramps. See the Ramp Meter Design Manual for additional information. When adequate storage length cannot be provided, the capacity advantages of the SPI diminish.

Bicycles

The presence of bicycles can affect the decision to choose a SPI. Due to their slower speeds, bicycles may adversely affect the capacity and operation of motor vehicles at SPI intersections, thereby negating the benefits of choosing a SPI over another interchange alternative. The required green and all-red clearance intervals necessary for a bicycle to clear most SPI intersections are substantially longer than what is needed for a motor vehicle. The required extended signal timing increases delay for motorists. Accommodation of bicyclists through the SPI intersection is an important consideration. Section 2–800, "Pedestrians and Bicycles" discusses how to accommodate bicyclists through SPI intersections.

Pedestrians

Because signals at SPI intersections are timed to move motorists efficiently through the intersection, pedestrians normally can only cross a portion of the intersection in a single cycle. It may take a pedestrian as many as four cycles to cross the separate ramps connections along the local street as opposed to typically two to four crossings at conventional tight diamonds and partial cloverleaf interchanges. Pedestrians shall be prohibited from crossing the local street within the interchange.

SPIs with incorporated Frontage Roads

SPIs incorporating frontage roads should be avoided.

This configuration requires that the frontage roads be one-way and in the direction of ramp traffic. A slip ramp from the mainline to the frontage road provides access to and from the intersection. An SPI incorporating frontage roads by combining the ramps and frontage road is shown in the 1994 AASHTO "Green Book", Figure X-25.

A fourth signal phase is required with this configuration to allow through moves on the frontage roads. This layout typically requires at least 90 m between stop bars, thus diminishing operational efficiency. The fourth signal phase and additional intersection size required to accommodate frontage roads reduces the available green time. Normally bicycles are allowed to use the traffic lanes or shoulders and can legally turn left at an intersection. In order to accommodate a left turning bicycle in an SPI, longer signal timing is required. This longer signal timing makes the intersection operate inefficiently. At three-phase SPI intersections, bicyclists will normally not be turning left onto the freeways but will be proceeding as through traffic along the local cross streets.

## 1-500 PARALLEL LOCAL STREETS

In order to take advantage of the three-phase signal of an SPI intersection, the local street system must be able to accept and deliver the traffic. Short spacing from the ramp intersection to adjacent local streets and driveways will limit the ability for the local street system to handle the large volumes of through traffic that the SPI can deliver. The purported advantages of the SPI will often not materialize where the local street system is not compatible.

## 1-600 OPERATIONAL EXPENSE AND FUTURE PLANNING

SPIs are normally more difficult to operate and maintain than conventional diamond configurations. Their size and shape requires more maintenance effort for structures, electrical, signing, delineation and pavement markings. SPIs constructed with "butterfly" shaped structures lack flexibility for future modifications or expansion (see Section, 1-800 "Construction Costs"). If future expansion or modification is needed, major reconstruction of the structure will typically be necessary due to the complexity of the structure design. Because of the size and geometrics of the SPI, widening of the freeway, local street, or ramp terminals is normally more expensive than for conventional interchanges. This holds true for either overcrossings or undercrossings.

## 1-700 POWER FAILURE OR FLASHING OPERATION

Intersection operations during conditions of power failure or flashing signals, especially during periods of darkness, requires particular attention. The size of the intersection and

position of the entering vehicles complicate the required “stop and proceed in order of arrival” rule. Manually directing traffic will be difficult on an SPI intersection without signal control. Plans for operation of the SPI intersection during power outages should be developed cooperatively between California Department of Transportation and the appropriate local agency.

### 1-800 CONSTRUCTION COSTS AND STAGING

SPIs require a substantial initial investment. Significant differences in construction costs exist between the SPI and other conventional interchanges. Additional costs are attributed to the larger structure surface area, additional vertical clearance required at undercrossings, retaining walls, and overhead sign structures.

Staging for SPIs can be more difficult than other interchange types and may result in local street closures. It is important that proposed SPIs receive a constructability review in accordance with current procedures.

### 1-900 ALTERNATIVE SELECTION

Compared to SPIs, diamond and parclo interchanges often result in lower construction costs as well as reduced future maintenance and expansion costs. The choice of interchange type should be based upon the best combination of expense and desired results. The SPI should not be arbitrarily chosen without considering other alternatives. In addition to the "no-build" alternative, an SPI should be compared to a diamond interchange in the project initiation document. Safety, construction costs, maintenance costs, projected traffic demands, right of way impacts, expected bicycle and pedestrian usage, interchange type, and site conditions factor into choosing the best alternative.

## SECTION 2 - GEOMETRIC DESIGN

### 2-100 DESIGN SPEED

The standards for design speed discussed in the HDM Topic 101 apply to SPIs. The design speed should reflect the anticipated 85$^{th}$ percentile speed. However, the selected design speed should not be lower than the posted speed limit. The Project Development Coordinator must concur with the design speed chosen for the local street. Design speed should not be lowered to accommodate economy of design. Design speed of the ramps must be consistent with Index 504.3 of the HDM except as discussed in these guidelines.

#### 2-101 Sight Distance and Visibility

Visibility is a key feature to ensure safe and efficient operation of SPIs. To avoid confusion, drivers must have clear visibility of all pavement, signing, delineation, signals, and curbs within the intersection. It is important that

drivers be able to see and understand their destination and path through the intersection. Decision Sight Distance per Table 2-101.1 shall be provided through the SPI intersection along the local street extending 50 m beyond the stop bars. Decision sight distance is measured from a driver's eye height of 1070 mm to an object height of 150 mm.

**Table 2-101.1**
**Sight Distance**

| Design Speed (km/h) | Stopping Sight Dist (m) | 7 1/2 sec Corner Sight Distance (m) | Decision Sight Distance (m) |
|---|---|---|---|
| 40 | 50 | 90 | 110 |
| 50 | 65 | 110 | 145 |
| 55 | 75 | 120 | 160 |
| 60 | 85 | 130 | 175 |
| 70 | 105 | 150 | 200 |
| 75 | 118 | 160 | 215 |
| 80 | 130 | 170 | 230 |
| 90 | 160 | 190 | 275 |
| 100 | 190 | 210 | 315 |
| 110 | 220 | 230 | 335 |
| 120 | 255 | | 375 |

To verify the driver's ability to see the pavement, signing, delineation, signals, and curbs within the intersection, the designer should plot the vertical alignment of each move through the intersection. As would be expected, curbs and raised markers can be seen and understood from further distances because they are raised above the pavement. Based upon field observations, the striping and pavement can be understood by drivers at approximately half of the sight distance on longer crest vertical curves. Table 2-101.2 shows the relationship between sight distance* and the distance that markings on the pavement are visible.

**Table 2-101.2**

| Sight Distance* | Distance to Visible Striping** |
|---|---|
| 110 m | 65 m |
| 130 m | 75 m |
| 160 m | 80 m |
| 190 m | 90 m |
| 220 m | 105 m |
| 250 m | 120 m |

* Sight Distance is measured from the driver's eye (1070 mm) to a 150 mm object.
** Distance is from the driver's eye to limits of perceivable pavement delineation. The basis for this measurement is field observation.

This relationship can be helpful in determining visibility of delineation features on SPIs located on crest vertical curves. This information is provided as background material and should not be misconstrued as design criteria. The intent is to provide the reader or designer with information on the relationship between sight distance and the visibility of delineation.

## 2-102 Vertical Alignment

It is undesirable for the SPI intersection to be located on a crest vertical curve due to the reduction in visibility. The vertical alignment of local streets should have a constant grade or sag vertical curve through the intersection.

Undercrossing vertical alignments should be designed with enough vertical clearance to accommodate signal heads beneath the soffit without reducing visibility to the signal heads. See Section 6-200, "Undercrossings" for related signal guidelines.

## 2-103 Horizontal Alignment

The horizontal alignment of the local street should be constructed on tangent through the intersection. Where the local street is on tangent, delineation and signing can be better understood by the driver before entering the intersection. When the local street alignment is in a curve, it may be difficult for the driver to determine the proper lane as they approach the SPI intersection.

Where compound curves are utilized for a left turn alignment through the SPI intersection, the smaller curve radius should be at least half that of the larger

curve radius. Broken back curves for left turn moves through the intersection should be avoided.

The exit ramps terminus should be designed to avoid aligning headlights into the eyes of drivers on the opposite exit ramp. Exit ramps on ascending grades are particularly prone to directing headlights into opposing exit ramp driver's eyes.

An important consideration for exit ramp left turn movements is adequate visibility to the stop bar and both signals at the ramp terminus (See Item 2-103 in Figure 1). Note that at least two signals are required for exit ramp left turn moves. Place at least one overhead signal near the center of the intersection, and the second signal head mounted on the divisional island or "pork chop" island. See Section 6, " Traffic Signals" and Figure 4A & 4B.

Geometrics for left turn moves provide for higher speeds at SPIs than at typical ramp intersections, therefore stopping sight distance shall be provided along the off-ramp left turn segment. This shall match or exceed the design speed provided by the ramp's horizontal alignment in accordance with Table 203.2 of the Highway Design Manual and be at least 40 km/hr; Index 504.3(1)(a) not withstanding.

### 2-104 Corner Sight Distance at Exit Ramps

It is important to provide visibility between exit ramp traffic and cross traffic approaching from the left (See Figure 1, Item 2-104). Pedestrian fencing on overcrossings or the bridge abutment on undercrossings may obstruct visibility. There are both safety and operational benefits associated with adequate corner sight distance. If drivers in a queue cannot see approaching vehicles, each driver may tend to slow and creep into the intersection, thus reducing the capacity of the ramp and hindering the operation of the intersection. Intervisibility between vehicles improves safety.

Corner sight distance should be provided from a point 12m before the exit ramp left turn stop bar. Where restrictive situations exist, the minimum corner sight distance shall be equal to the stopping sight distance provided from the same point.

## 2-200 INTERSECTION SIZE

Minimizing intersection size can be the most significant factor in successful SPI operation. SPI intersections operate best when they are small and compact. See Figure 6 and Section 2-800, "Pedestrians and Bicycles" for information regarding Compact SPIs. Larger intersections require longer paths for vehicles to traverse through the intersection. Drivers may have difficulty identifying key features such as ramp entrances and therefore have difficulty properly traversing the facility. Smaller intersections typically improve the

driver's ability to identify and understand the intersection layout, thereby reducing driver confusion and the potential for wrong way moves. Larger intersections also complicate movements for bicyclists. Bicycle issues are covered in more detail in Sections 1-400, "Capacity" and 2-800, "Pedestrians and Bicycles".

Signal operation has a direct relationship to intersection size. The amount of red clearance time increases with intersection size, thus increasing the overall signal timing cycle length, requiring more storage for waiting traffic and reducing the efficiency of the intersection. In addition, larger intersections expose vehicles to conflicts for longer periods of time.

If an SPI is proposed without a separate bicycle facility, it shall be a Compact SPI. Where a separate bicycle facility is provided in conjunction with an SPI, the following intersection size criteria applies. Where an SPI intersection is located on a crest vertical curve, the distance between opposing stop bars on the local street should not be greater than 50 meters, but shall not be greater than 60 meters. Where an SPI intersection is located on a sag vertical curve or at a constant grade, the distance between opposing stop bars on the local street should not be greater than 60 meters, but shall not be greater than 70 meters.

The following geometric features can reduce the size of a SPI intersection:

1. Increasing the median width of the local street allows the local street stop bars to be placed near the center of the intersection. This aspect can be difficult to visualize but is easily understood if the designer draws and compares the effects of different median widths.

2. Field observations noted that vehicles frequently stop beyond the stop bar and idle within the intersection. A wider median width includes space between the through move stop bars and left turn moves which may compensate for driver error.

3. At undercrossings, signals should be hung beneath the bridge soffit. The vertical clearance should be sufficient to hang signal heads vertically, thus allowing local street stop bars to be located nearer the center of the intersection. See Section 6-200, "Undercrossings" for additional information on signal placement at undercrossings.

## 2-300 RIGHT TURNS AT EXIT RAMPS

The free right turn moves at the exit ramps are a basic feature of the typical SPI. Lack of a free right can negatively impact operational efficiency. Figure 1 illustrates three common approaches to right turn lane configurations at exit ramps.

The free right turn lane, as shown in Item 2-300(1) in Figure 1, is a typical feature of SPIs and should be used when the right turning vehicles enter the local street in their own lane, and adequate weave and merge lengths can be provided downstream. If volumes are

too high for a single lane it is sometimes reasonable to add and signalize the #1 right turn lane as shown in Figure 1, Item 2-300(2). The signalized #1 right turn lane allows vehicles in this lane a protected movement to the local street. In some situations this configuration of a combination free right/signalized right turn layout can mitigate short weaves and merges related to close spacing of the ramp and adjacent local intersections. Where spacing between exit ramps and adjacent intersections is short and/or a large volume of vehicles weave across the local street to turn left at the adjacent intersection, consideration should be given to signalizing the right turn move at the ramp terminus as shown in Figure 1, Item 2-300(3).

Per Index 504.3(2) of the HDM, "Where a separate right turn lane is provided at ramp terminals, the turn lane should not continue as a free right unless pedestrian volumes are low, the right turn lane continues as a separate full width lane for at least 60 m prior to merging and access control is maintained for at least 60 m past the ramp intersection. Provision of the free right should also be precluded if left turn movements of any kind are allowed within 125 m of the ramp intersection." In addition, an analysis should be performed to verify that adequate merge and/or weave distance is provided. If the analysis indicates that additional lane length is required for merge and/or weave, the access control should be correspondingly extended.

## 2-400 LANE WIDTHS

The lane widths for left turn lanes should be 4.2 m through the intersection. Additional width may be required for truck off tracking (See HDM Table 504.3).

## 2-500 MERGING AND WEAVING DISTANCE FOR ENTRANCE RAMPS

A typical SPI entrance ramp accepts traffic from double left turn lanes and a free right turn lane. The ramp therefore commonly provides three lanes near the intersection. Since it is California Department of Transportation policy to build one lane entrances except under specific circumstances, three lanes must be merged into one prior to entering the freeway. Merges should occur one lane at a time and provide adequate length consistent with expected vehicle speeds under free flow conditions.

Where a turn lane converts into an HOV lane on the entrance ramps, adequate weaving distance should be provided to ensure vehicles entering the ramp can weave out of the HOV lane to a mixed flow lane. To avoid this weave, it may be feasible to begin an exclusive HOV lane on the local street leading to the ramp's HOV lane. Where this occurs, advance overhead signing should be installed to prepare drivers for the weave. When an exclusive HOV lane does not begin on the local street, an overhead sign should be placed at the ramp entrance stating "HOV ONLY AHEAD".

Where entrance ramps include an HOV bypass lane, adequate distance for merging from the far lane to the HOV lane should be provided.. A fourth lane on the entrance ramp should typically be avoided. Figure 1 illustrates the above concepts.

## 2-600 SKEW ANGLE

SPIs are best utilized when the freeway and local street alignments intersect at a ninety degree angle. Intersection skew angles should not exceed 15 degrees from normal. However, intersection skew angles shall not be greater than 30 degrees from normal.

## 2-700 CENTER ISLAND LAYOUT

A raised center island shall be provided. The minimum dimension shall be 1.8 m per side (3 m preferred) with a minimum surface area of 9 square meters. All lanes shall have a 0.6 m offset from the raised center island. See Figure 3, and Section 3-100, "Center Island" for additional information.

## 2-800 PEDESTRIANS AND BICYCLES

SPIs are efficient in moving high volumes of motor vehicle traffic, particularly left turn movements. Due to their slower speeds, bicyclists are typically difficult to accommodate in the traffic lanes or shoulders without adversely affecting the operational efficiency of the SPI. If moderate to heavy bicycle usage is expected, consideration should be given to selecting a more compatible interchange type. For design purposes, bicyclists are estimated to travel at a speed of 4.5 meters per second and pedestrians at 1.2 meters per second through a level intersection. Therefore, if signal timing were set to accommodate bicyclists and pedestrians, motorists would experience excessive delay waiting for a signal to change.

Figure 6 shows a Compact SPI designed to accommodate bicyclists, and minimize the intersection size thus improve overall operations. An SPI with a 25 m maximum distance from the stop bar to the conflict point is considered a Compact SPI. The conflict point is defined as the middle of the far lane for turning vehicles that bicyclists must cross under a single signal phase. Single free right turn lanes are an integral part of the Compact SPI design, and are considered independent of the signalization. The Compact SPI design utilizes a single lane free right turn lane so bicyclists need to cross only one lane of uncontrolled traffic. However in order to be able to provide free right turn lanes, adequate weave and merge distance from the free right turn to the adjacent intersection must be provided. See Section 300, "Right Turns at Exit Ramps" and the HDM for discussions regarding free right turn movements. In some situations the right turn move can be handled with stop control and thus adequately accommodate bicyclists.

To accommodate bicyclists through SPI intersections, all SPI alternatives shall be Compact SPI except as discussed in the following. If an SPI alternative other than a Compact SPI is chosen, a separate bicycle facility shall be constructed in conjunction with the SPI. The

separate bicycle facility would typically be a bicycle overcrossing or undercrossing and should be located in the immediate vicinity of the SPI to minimize out of direction travel by bicyclists. It should be noted that where the right turn movement is signalized, the conflict point is the middle of the far right turn lane. If it is anticipated that in the future the right turn move at a Compact SPI will be signalized, a separate bicycle facility should be incorporated into the current project.

Bicycle push buttons to extend the next through-move green phase for bicyclists have been installed in California. The push button is located at the limit line and near the curb facing the street for easy bicyclist access. This allows the bicyclist to cross the SPI with minimum conflict. The longer green phase however increases the delay to motor vehicles at the intersection and thus reducing its efficiency. This concept may be applicable at other existing SPIs. Where bicycle push buttons are installed at SPIs, a sign advising bicyclists that pushing the button will provide an extended green light on the next cycle shall be installed. The sign should be white on green, have a bicycle symbol and say: "Push button for more time on next green."

Signals at SPIs are timed to move motorists efficiently through the intersection; pedestrians are normally allowed to proceed as far across the intersection as they can in a single phase. Due to the substantial length across the intersection it may take a pedestrian as many as four cycles to cross the interchange as shown in Figure 1.

To safely accommodate pedestrians, a pedestrian push button shall be installed.

## SECTION 3 ISLAND FEATURES

### 3-100 CENTER ISLAND

Consistent with Sections 2-400, “Lane Widths” and 2-700, “Center Islands Layout” of these Guidelines and to facilitate orderly left turn moves, a raised center island as shown in Figure 3 should be provided. The island perimeter should be 80 mm mountable curb. For more information, reference Index 405.4, Traffic Islands, of the HDM.

### 3-200 MEDIAN ISLANDS

Opposing through traffic on the local street approaching and departing an SPI intersection shall be separated by a raised concrete median. Use a Type A barrier curb within the influence area of the SPI intersection. Raised medians adjacent to a left turn lane should have a minimum width of 1.2 m. A 3.6 m minimum median width is recommended for separation between opposing through lanes (See discussion regarding median width in Section 2-200, “Intersection Size”). Type K markers and R7 signs are required on the median island bull nose.

### 3-300 LEFT TURN CHANNELIZATION OF LOCAL STREET

On local streets, a striped channelization island to separate left turning vehicles from through vehicles may be provided as shown on Figure 2. If used, the island should consist of 200 mm white thermoplastic striping. The island should be at least 1.5 m wide at the widest point. The island should direct the left turning vehicles towards the freeway on-ramps. A striped divisional island or "pork chop" island (see Figure 6) shall be provided beyond the left turn lane stop bar.

### 3-400 RAMP ISLANDS

The channelizing island separating the left and right turn lanes where on and off ramps connect to the local street shall be a raised island. The island facilitates pedestrian traffic and must be clear of landscaping or other obstructions that could restrict sight distance. Use a 200 mm vertical (barrier) curb surrounding the island perimeter, with Type K markers at the ramp island nose.

## SECTION 4 PAVEMENT DELINEATION AND MARKINGS

The HQ Traffic Liaison shall approve all final signing, striping and signalization plans for SPIs.

### 4-100 PAVEMENT COLOR

Bridge decks should be a dark color to improve contrast between deck and delineation.

Proper striping and delineation are valuable tools to provide guidance through the intersection. A dark colored deck is beneficial to increase visibility of pavement markings, curbs and other interchange features. Some recommended treatments are dyed PCC, open graded AC, iron oxide-epoxy seal, or a slurry-seal coated PCC. Consult Structures Maintenance and District Maintenance prior to choosing a surface treatment.

### 4-200 PAVEMENT MARKING MATERIALS

In an effort to reduce lane closures and associated maintenance problems, thermoplastic is recommended for all permanent pavement markings and legends. If thermoplastic is selected as a marking material, consult with the HQ Traffic Liaison regarding the most appropriate type. SPI maintenance operations can require lane closures, which can be problematic and disrupt traffic.

100mm thermoplastic striping material of appropriate color shall be applied around all raised medians and islands, and surround center islands with a 200mm white thermoplastic stripe.

### 4-300 LANE LINE EXTENSIONS (SWINGLINES)

In an effort to help guide drivers through SPI intersections, swinglines (Detail 40 plus reflective markers at approximately 6.4 m on center) shall be provided for all left turn movements. This will usually be the centerline between double left turn movements. In some instances a second swingline may be appropriate at the left edge of the left lane. Left edge swinglines consisting of Type AY markers or Type H markers spaced no closer than 1.2 m on center for motorists in the number 1 lane may be considered for vehicles turning left from the exit ramp to the local road on larger intersections and/or through crest vertical curves.

### 4-400 STOP BARS

In an effort to increase visibility and driver conformance, all stop bars should be white thermoplastic, 0.6 m in width.

### 4-500 PAVEMENT MARKINGS

Conflicting or numerous pavement markings can contribute to driver confusion. Pavement markings between the stop bars at an SPI intersection should be kept to a minimum. Directional arrows or legends between stop bars at SPI intersections should be avoided. However, all lanes approaching the intersection should be clearly marked with the appropriate directional arrows. Additionally, directional arrows shall be placed adjacent to all stop bars. See Figure 2.

## SECTION 5 - SIGNS

The HQ Traffic Liaison shall approve all final signing, striping and signalization plans for SPIs.

### 5-100 STANDARD SIGNAGE

All standard interchange sign packages (R10, R11 etc.) are required and must be located where they are clearly visible to reduce the risk of wrong way moves at exit ramps. In addition to the standard sign packages, the following signs shall be installed at SPIs.

### 5-200 GUIDE SIGNS

For SPI overcrossings, on-ramp entrances for left turn moves should have G85 signs with arrows mounted on sign bridges as shown in Figure 3. Additionally, G85 & G83 signs are required over local streets on all approaches to the SPI intersection as shown. Guide signage should not be located where they could impair traffic signal visibility. It is desirable to place the G83 in line with the G85 signs on the local street. However, in instances where turn pocket length prevents the placement of these signs in line, the G83 should be placed on the local cross streets as appropriate.

## 5-300 CENTER/MEDIAN ISLAND SIGNAGE

The center island should be signed with W57 and type N markers placed back-to-back facing each exit ramp, and type K markers at the noses as shown in Figure 3. Signs should be placed for maximum visibility to approaching traffic and to reduce the chance for driver confusion that may be caused by opposing headlights and geometry as discussed in 2-103, "Horizontal alignment". Signs in the center island shall be mounted on break away posts.

Median island noses must be signed with R7 signs mounted on break away posts and type K markers.

## 5-400 U-TURNS

U-turns are prohibited on the local roads when exit ramp right turns are signalized due to the overlap of traffic signal phasing. Proper signage must be placed prohibiting this U-turn movement. R34 (No U-turn) signs may be placed on the traffic signal bridge or adjacent to the traffic signal heads. U-turns may be allowed at SPIs as long as the U-turn does not conflict with other movements.

Pedestrian signals must be timed only with the local street through move because of conflicts with U-turns from exit ramps.

## 5-500 RIGHT TURN ON RED

One of the primary benefits of SPIs is its ability to move large volumes of traffic through the intersection(s). Therefore, SPIs should be designed to allow for free right turns when possible. However, where a free right turn is not feasible as discussed in Section 2 - 300, "Right Turns at Exit Ramps", consideration should be given to installation of a traffic signal to control this movement. At signal controlled right turn lanes, traffic should be allowed to turn right on red when practical.

In instances where right turn on red is allowed, a sign indicating that right turn on red is allowed should be placed. Where right turn on red is not allowed, a sign indicating that right turn on red is prohibited (R13) shall be placed.

This sign will reduce the risk of driver confusion on the nature of this movement and in enforcement.

## 5-600 SIGNS ON TRAFFIC SIGNAL BRIDGE

No guide signs are allowed on the traffic signal bridge or adjacent to overhead traffic signal heads. In an effort to increase visibility of the traffic signal, signage should be minimized on the traffic signal bridge.

# SECTION 6 - TRAFFIC SIGNALS

The HQ Traffic Liaison shall approve all final signing, striping and signalization plans for SPIs.

## 6-100 OVERCROSSINGS - TRAFFIC SIGNAL BRIDGE

On SPI overcrossings, a traffic signal bridge spanning the width of the intersection is required. The traffic signal bridge should be placed over the center of the intersection and perpendicular to the through traffic movement. When there are two or more left turn lanes, two signal indications shall be mounted on the signal bridge for that movement. When there are two or more through lanes, two signal indications shall be mounted on the signal bridge for that movement. Signals for right turn movements should be placed as shown in Figure 4A. Far side signals beyond the signal bridge are not allowed. Additional signal indications may be placed on separate poles as shown in Figure 4A. In an effort to increase signal visibility, overhead guide signs, decorative features, artwork, and extraneous messages are not permitted on the signal bridge.

Additionally, as is consistent with good design practices and intersection safety, lighting should not be located where direct or scatter light could possibly reduce the visibility of the signal indications.

## 6-200 UNDERCROSSINGS

On SPI undercrossings, traffic signals should be mounted under the structure, to minimize intersection width. Oversized back plates are recommended to reduce backlight. If intersection width standards and signal set back requirements can be met, signals may be placed on the face of the SPI structure.

## 6-300 SIGNAL HEADS

Traffic signal heads, except the near right signal, shall be 300 mm or greater in diameter. Programmable visibility heads shall not be used. -Signals shall be hung vertically as horizontal traffic signals could cause difficulties for colorblind drivers.
In areas where increased visibility is desirable, oversized traffic signal heads may be used. Use appropriate arrow signal lenses for turn movements (45-degree angle is preferred). The indication for through movements must be standard circular lenses.

## 6-400 SIGNAL PLACEMENT

Signal poles shall not be placed in the center island or on the median island bull nose. Signals may be placed in median islands to control the right turn movements from the freeway exit ramps. See Figure 4A for an example.

There shall be no signal heads located at the far side of the intersection facing through traffic on the local street.

### 6-500 MAINTENANCE CONSIDERATIONS

SPIs can be more difficult to maintain than other types of interchanges. For ease of maintenance, access to signal heads and signs located over the center of the intersection should be provided. The maintenance electricians must have access to the signal face. To avoid multiple lane closures during maintenance operations, overcrossings shall include a catwalk that provides access to all signals and signs located on the signal bridge. If the catwalk does not provide direct access to the face of the signal, the signals shall be made to rotate or pivot in the direction of the electrician.

## SECTION 7 - LIGHTING DESIGN

### 7-100 INTERSECTION SAFETY LIGHTING

Intersection safety lighting should be maintained at the SPI. The Traffic Manual requires 6.5 horizontal lux as the minimum maintained horizontal illuminance at the intersection of centerlines of the entering streets. Therefore, for SPI, this intersecting point would normally be in the vicinity of the center island that separates all the left turn movements.

Lighting should be provided at each on ramp entrance. All areas bounded by the crosswalks should have minimum maintained 1.6 horizontal lux.

For an overcrossing intersection, Type 15 or Type 21 structure electroliers should be used. High mast lighting may be used, except that it floods the area without emphasis to the ramp entrances.

Sign lighting shall not be allowed on the traffic signal bridge.

For an undercrossing intersection, 70 watts or 100 watts HPS flush mount soffit lighting should be used. The intersecting point of the centerlines should have the minimum maintained 6.5 horizontal lux. All areas bounded by the crosswalks should be lit by either soffit lighting under the structure or by Type 15 electroliers outside the structure area.

The intersection safety lighting should be maintained by the agency responsible for maintaining the signal, as it is an integral part of the traffic signal.

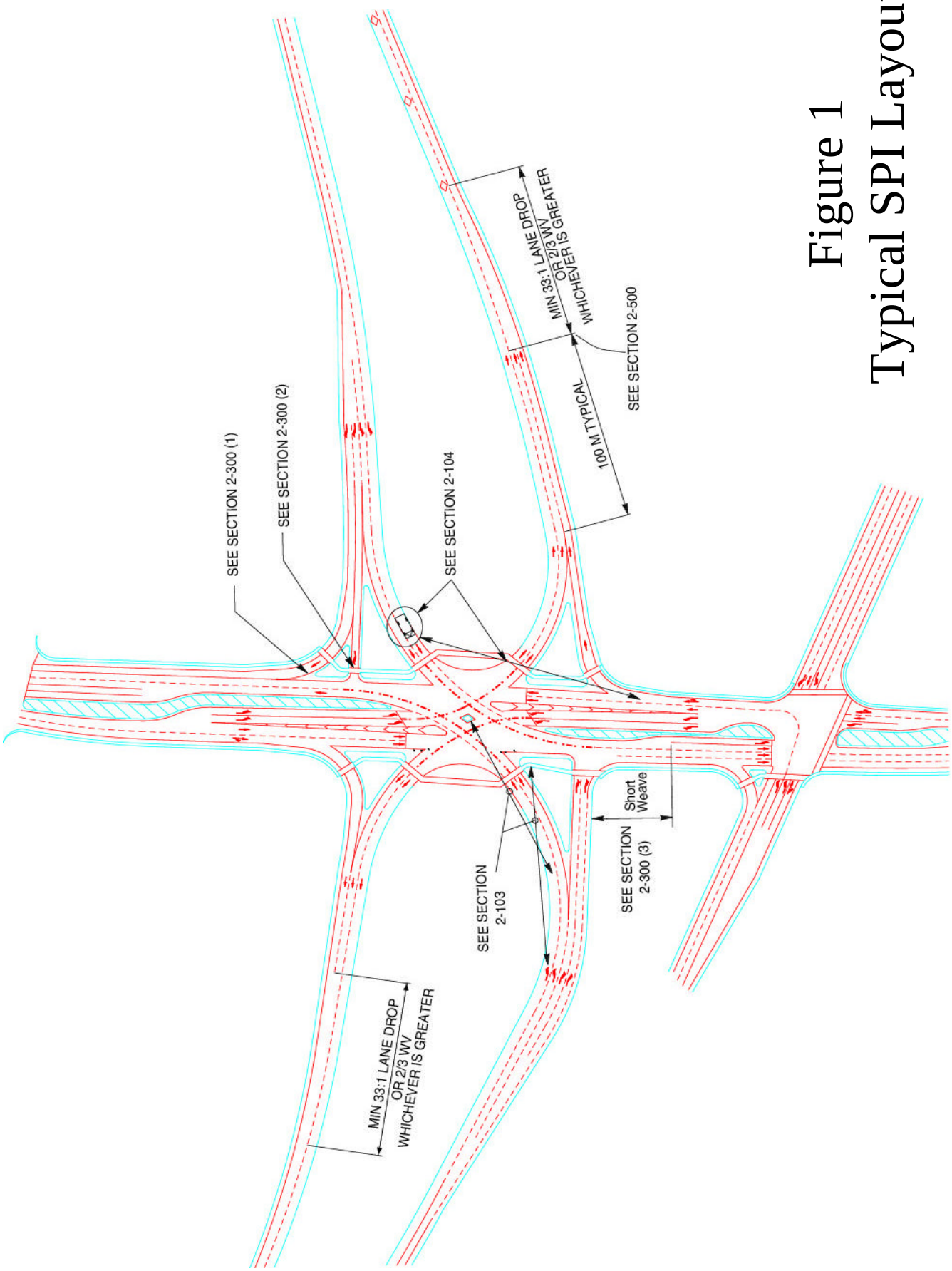
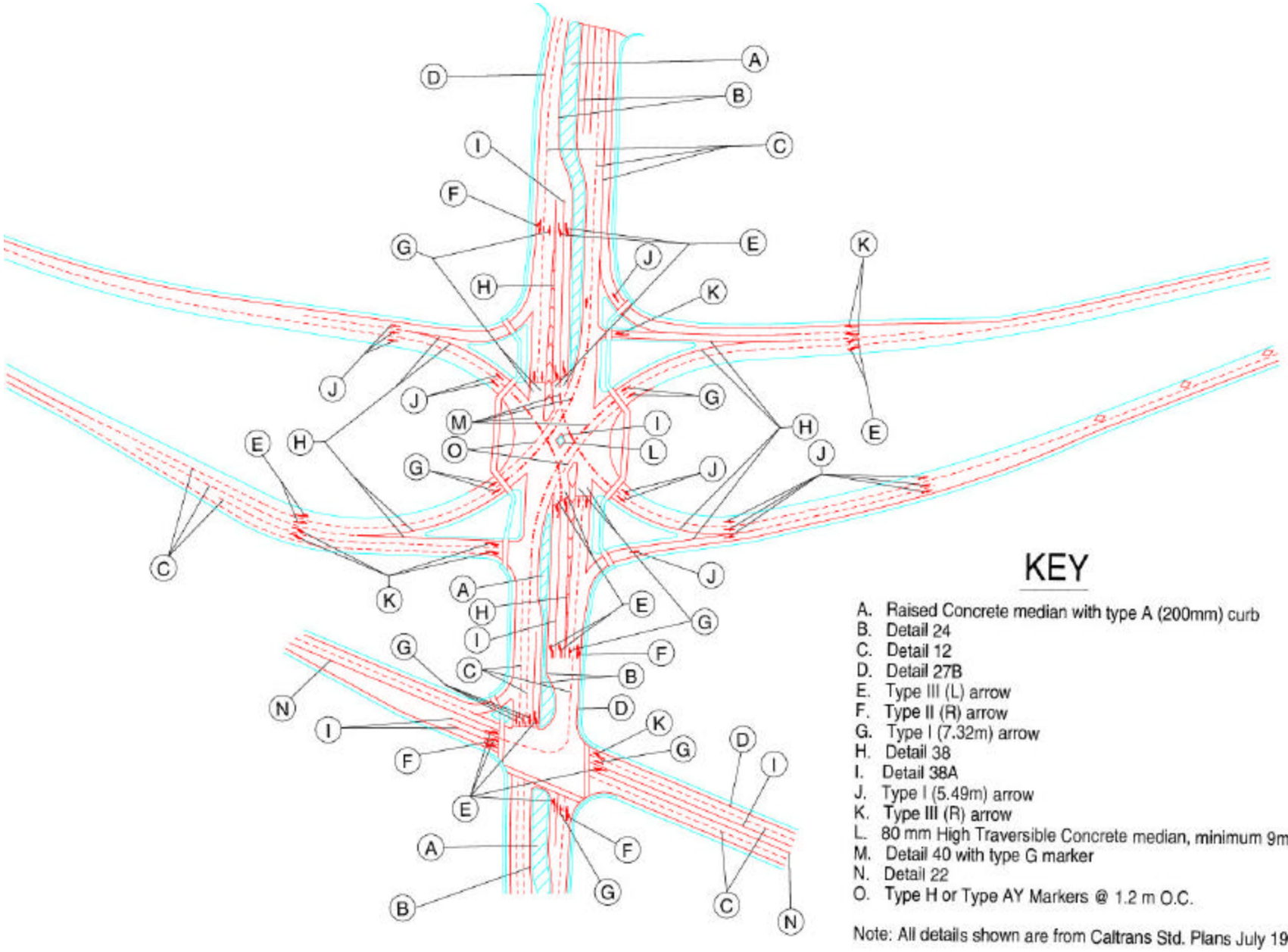
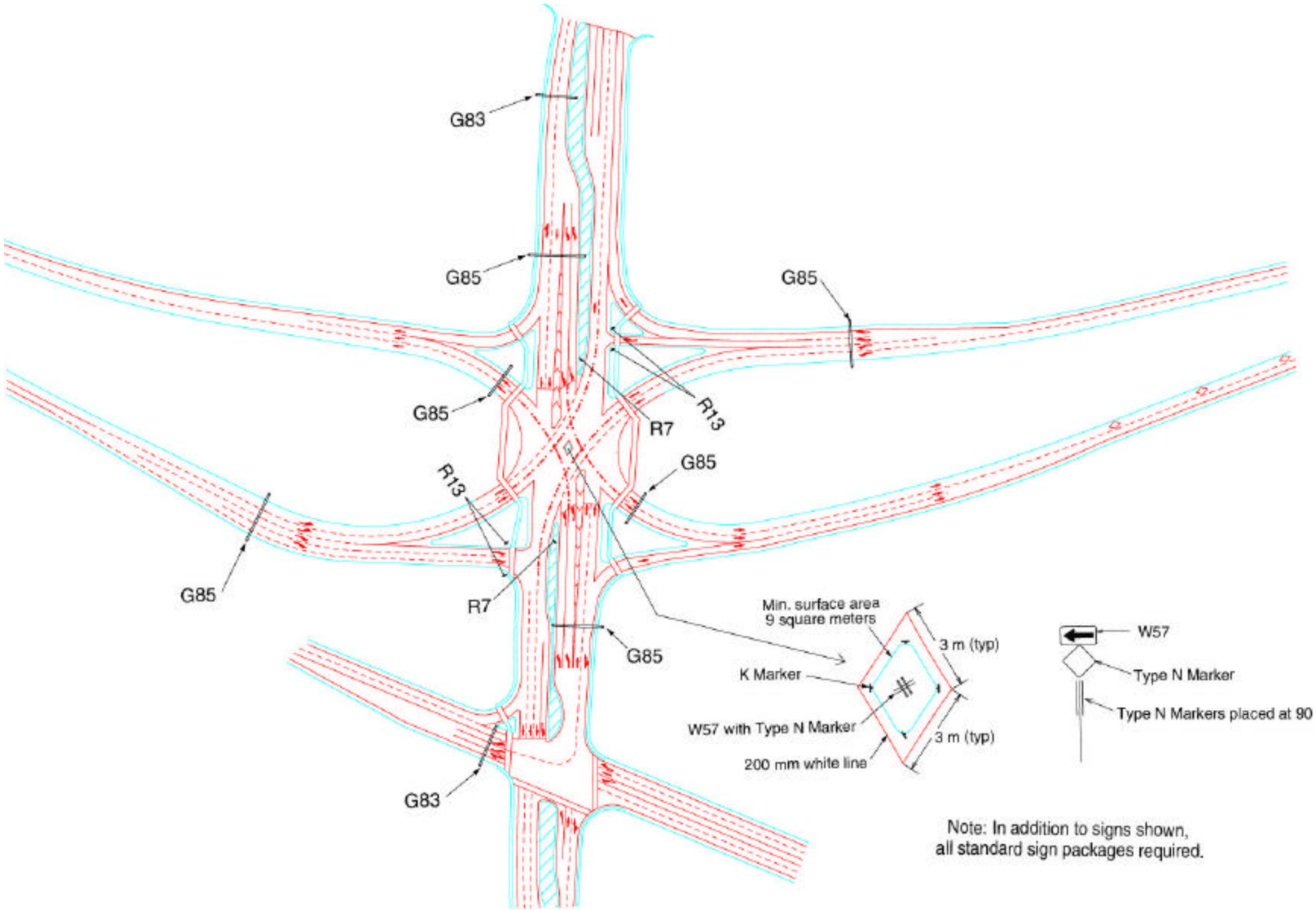



Figure 1
Typical SPI Layout




# Figure 2
# Typical Pavement Marking Plan




# Figure 3
# Partial Signing Plan

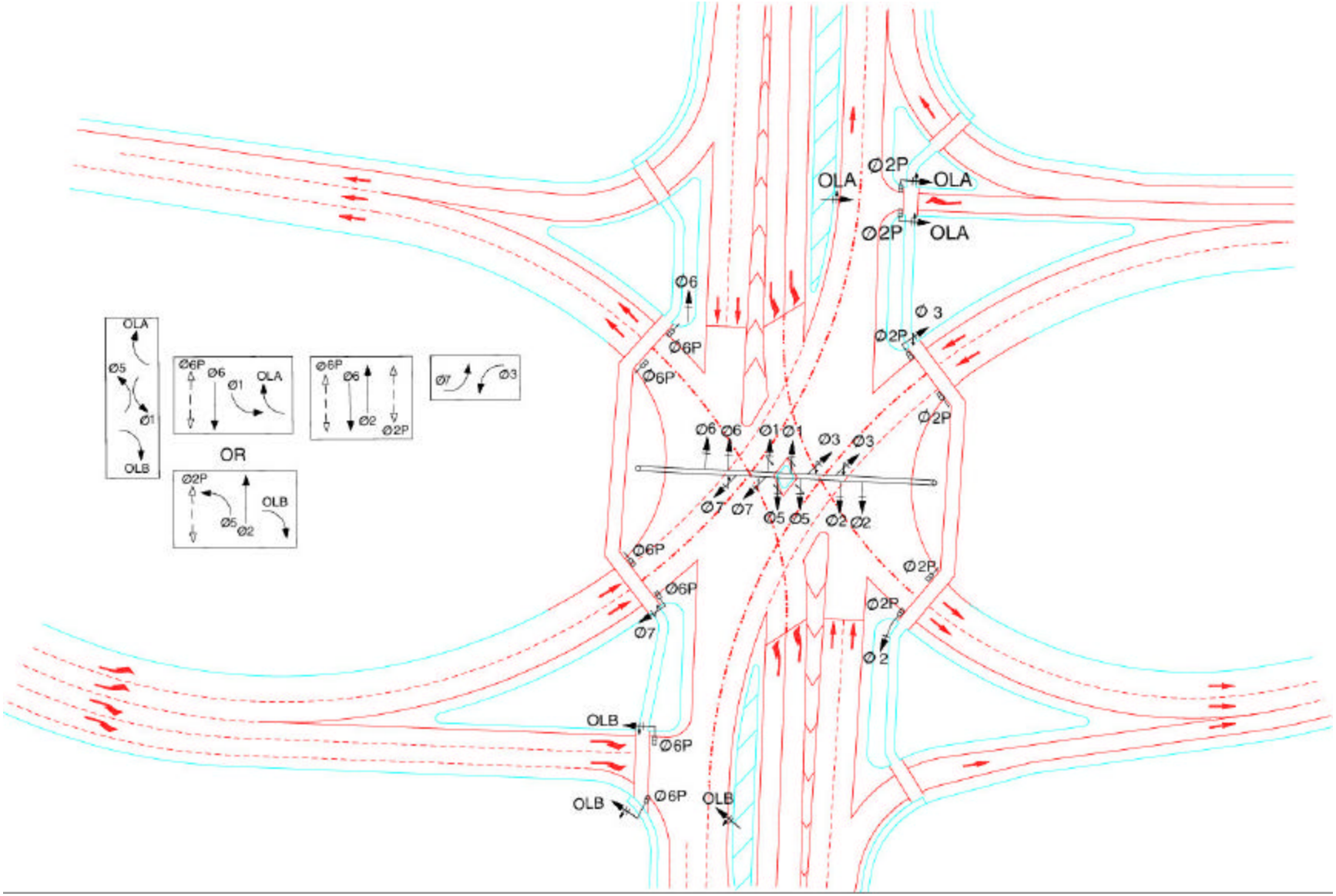
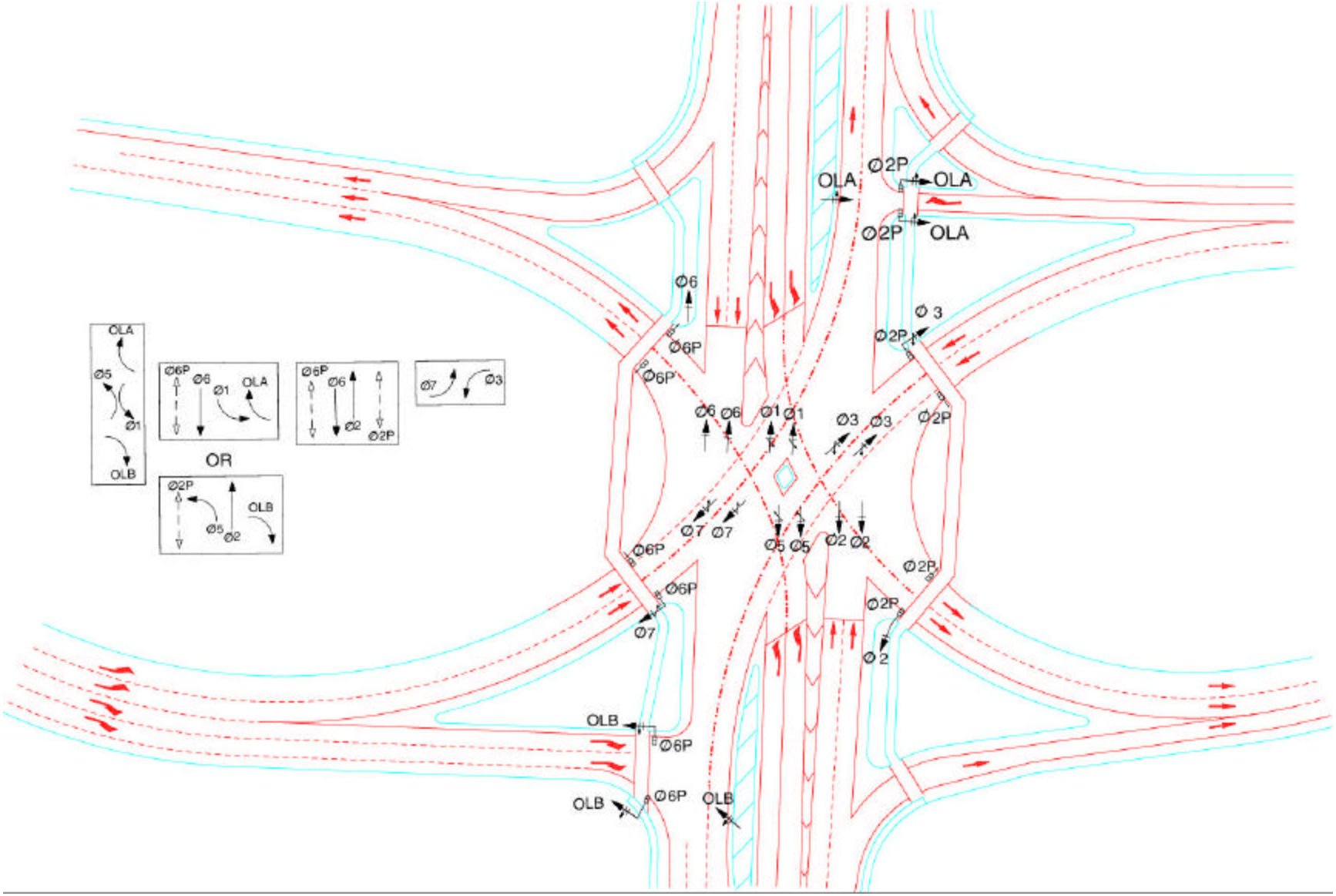
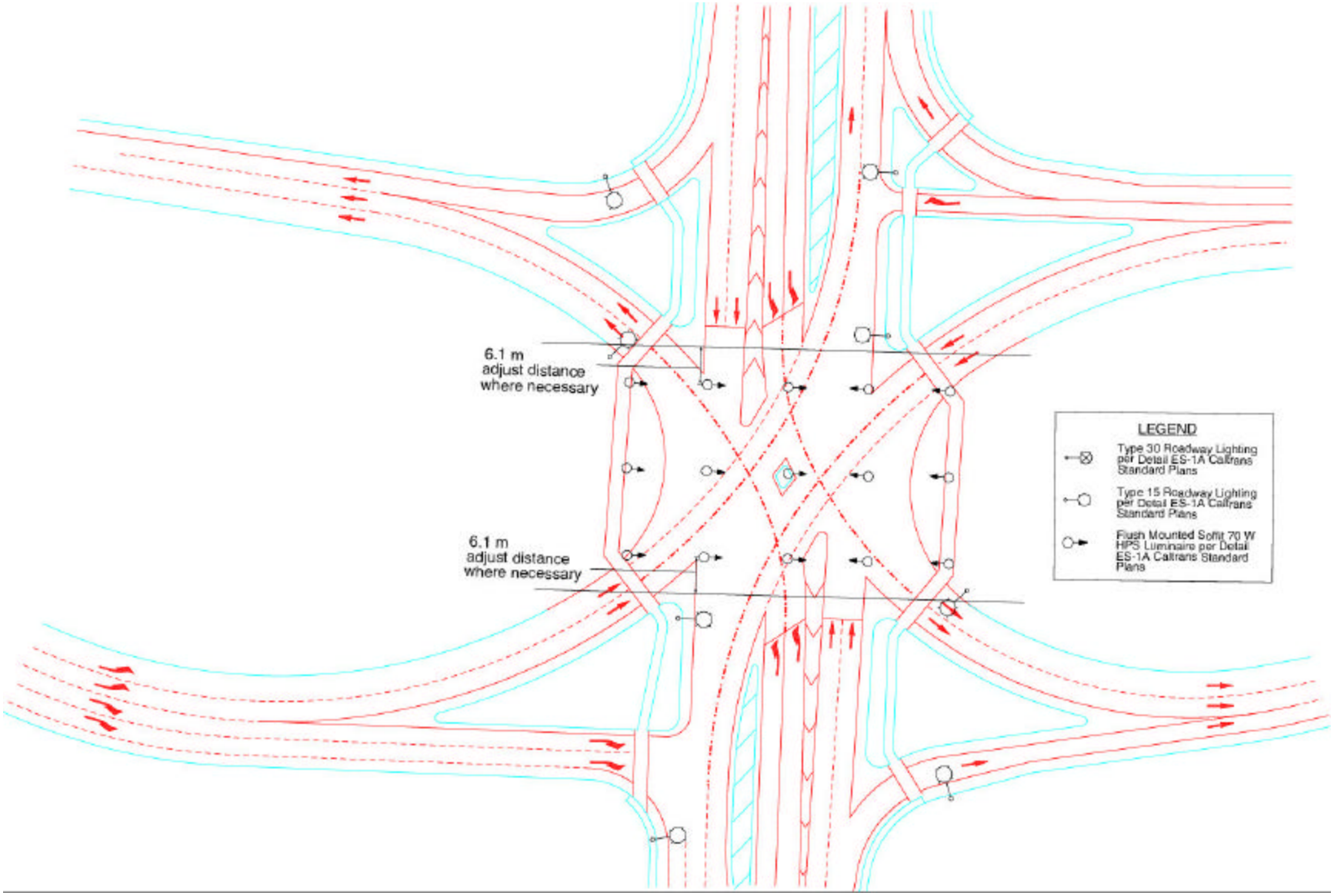



Figure 4A
Typical Signal Layout
(Overcrossing)




# Figure 4B
# Typical Signal Layout
# (Undercrossing)




# Figure 5A
# Typical Lighting Plan
# (Undercrossing)

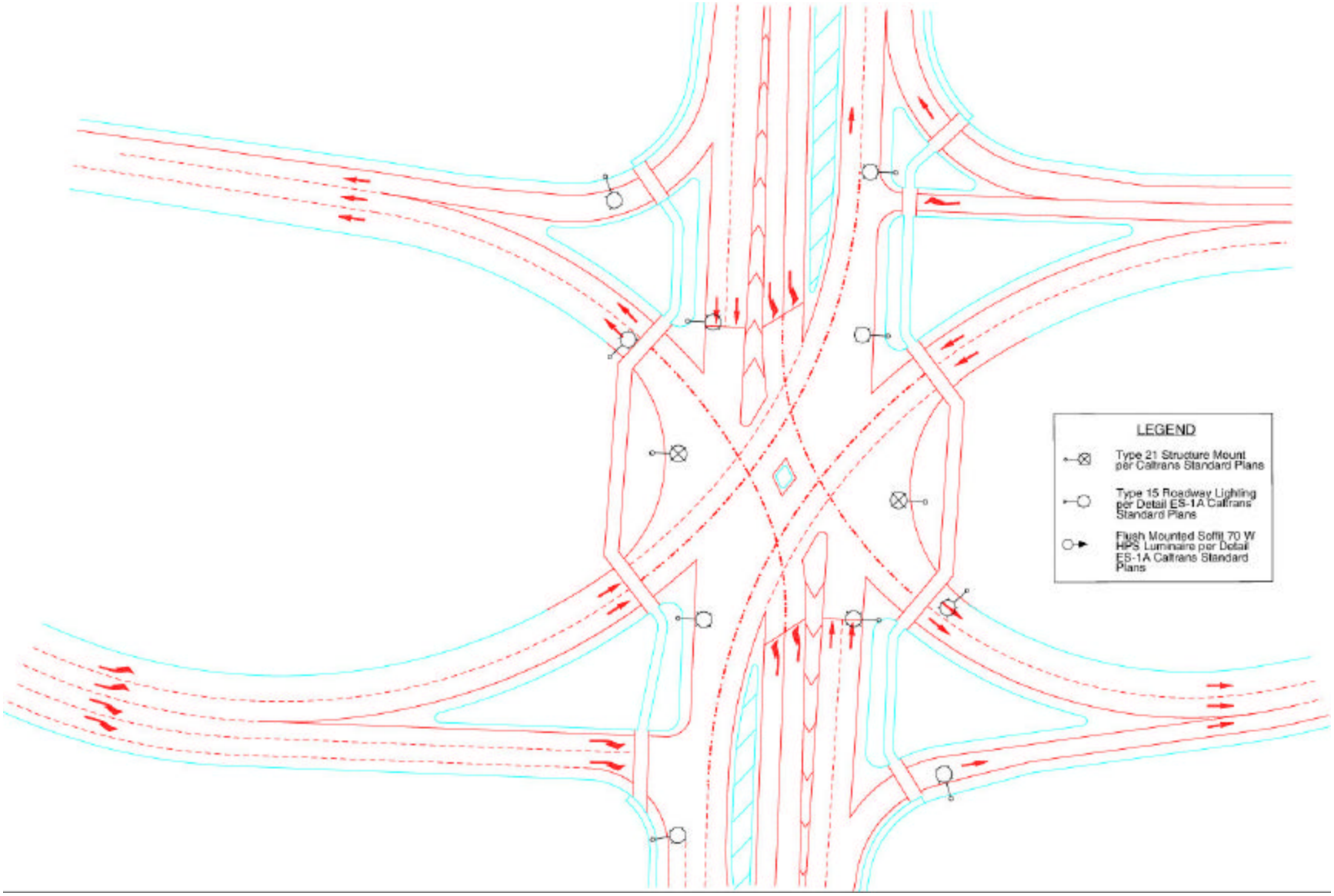



Figure 5B
Typical Lighting Plan
(Overcrossing)

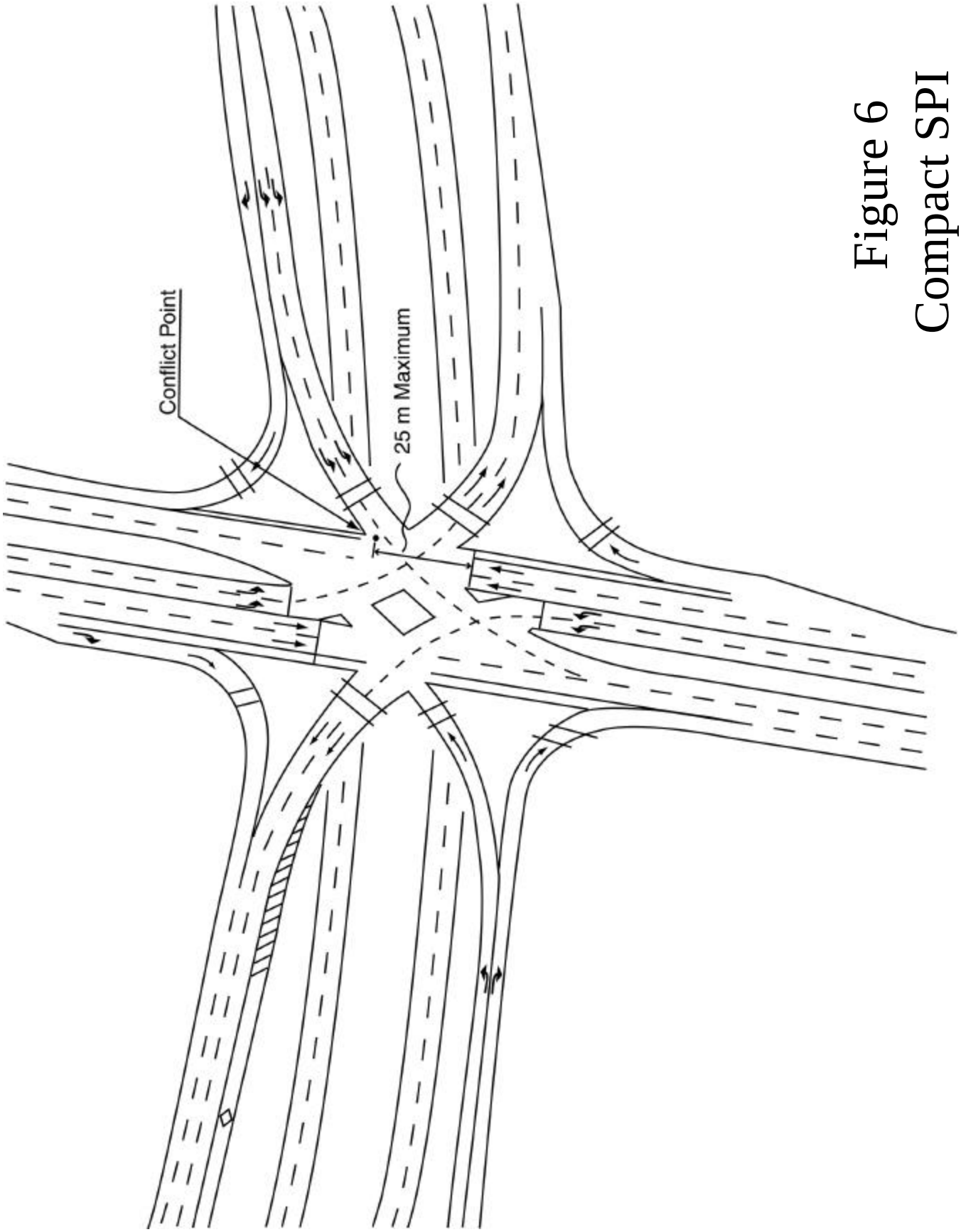



Figure 6
Compact SPI